

C9 Bridge and culvert repair

See the Office of Bridges and Structures web site for archived Methods Memos listed under articles in this section.

The Methods Memos for which policies have been partially revised and/or for which document references have been updated are noted as partially revised. Any obsolete Methods Memos that apply to this section are listed at the end.

C9.1 Bridge repair

Methods Memo No. 190: LRFD Guidelines for Repair Projects

1 March 2008

C9.1.1 Policy overview

C9.1.2 Design information

Partially revised: Methods Memo No. 141: Removal of Hazardous Paint

1 November 2005

Partially revised: Methods Memo No. 162: Bridge Railing Selection on Interstate and Primary Highways

29 June 2007

Methods Memo No. 190: LRFD Guidelines for Repair Projects

1 March 2008

Methods Memo No. 183: Policy Regarding Construction Loading

1 January 2008

C9.1.3 Definitions

C9.1.4 Abbreviations and notation

C9.1.5 References

C9.1.6 Field exams

Partially revised: Methods Memo No. 162: Bridge Railing Selection on Interstate and Primary Highways

29 June 2007

Methods Memo No. 190: LRFD Guidelines for Repair Projects

1 March 2008

Memo 9.1.6 et al.-2011 ~ Pedestrian and Bicyclist Access During Repair Projects

Unless a bridge can be closed during a repair project, vehicular access on the bridge must be maintained, but the bridge repair designer also needs to consider the needs of other users, including pedestrians and bicyclists on bridges with existing sidewalks, bicycle lanes, or shared use paths. For pedestrian and bicyclist access the designer cannot use the suggested temporary barrier rail layouts given in the Bridge and Culvert Repair section commentary [BDM C9.1.8.3] when developing a traffic control plan and should consult with the Office of Design and, in complex situations, also with the Office of Traffic and Safety. Along with pedestrian access the designer will need to address Americans with Disabilities Act (ADA) requirements. Although the Office of Design intends to consider all users

and ADA when developing traffic control plans for work zones [OD DM 9A-1 and 9A-5] the bridge repair designer needs to be aware of the issues and consult with the Office of Design as soon as possible in special situations.

C9.1.7 Rating

C9.1.8 Staging

C9.1.8.1 Structural considerations

Methods Memo No. 183: Policy Regarding Construction Loading
1 January 2008

C9.1.8.2 Construction considerations

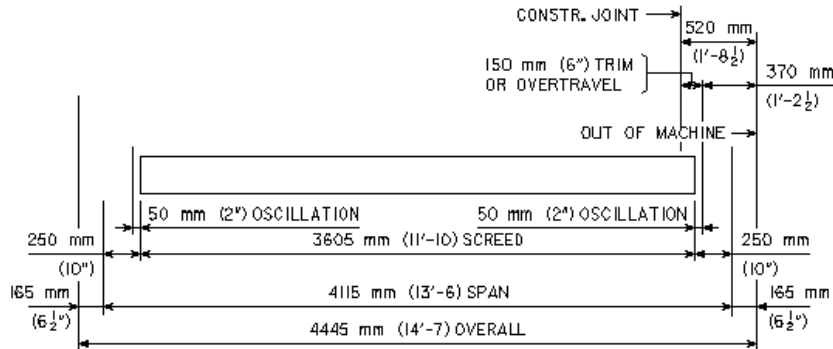
Methods Memo No. 58: Revision to Temporary Roadway Widths during Staged Construction
10 April 2006

Finishing machine dimensions for overlay and barrier rail

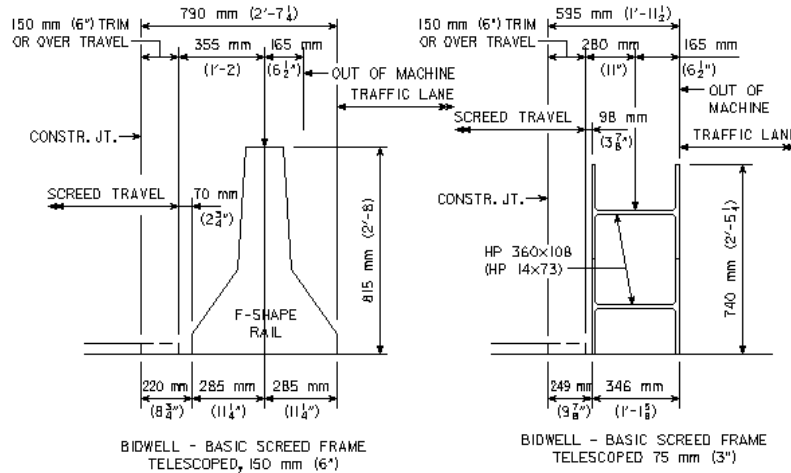
1998

BASIC BIDWELL
 BASIC SCREED = 3505 mm (11'-6") + 50 mm (2") END CAP + 50 mm (2") END CAP = 3605 mm (11'-10")
 SCREED + STROKE = 3705 mm (12'-2")
 SPAN - RAIL TO RAIL = 4115 mm (13'-6")
 OVERALL = 4445 mm (14'-7")

R. RISTING, CEDAR FALLS CONSTR.
 (FRAME CAN BE TELESCOPED OUT 915 mm (3'-0") EITHER END.
 TOWERS FOR VERTICAL ADJUSTMENT ADD 5 mm (1/4").



BASIC BIDWELL
 SCREED EXTENSION UP TO 1830 mm (6'-0") EITHER END (3660 mm (12'-0") FOR BOTH ENDS).
 SCREED EXTENSION UNITS OF 305 mm (1'-0"), 460 mm (1'-6"), 610 mm (2'-0"), 915 mm (3'-0"),
 AND 1830 mm (6'-0").
 FRAME SPAN CAN BE TELESCOPED OUT TO 5485 mm (18'-0") IN INCREMENTS OF 75 mm (3")±
 FRAME EXTENSIONS IN 610 mm (2'-0") INCREMENTS ARE AVAILABLE-
 2 WORKERS ONE DAY TO DISASSEMBLE AND REASSEMBLE FRAME.
 CONSIDERING TRIM EITHER SIDE, MAX. CONSTRUCTION LANE = 7010 mm (23'-0")
 GOMACO MACHINE HAS SIMILAR ARRANGEMENTS AND LIMITATIONS.



BRIDGE FLOOR REPAIR
 FINISHING MACHINE DIMENSIONS FOR STAGING OVERLAY
 1998

BRIDGE FLOOR REPAIR
 FINISHING MACHINE DIMENSIONS
 1998

C9.1.8.3 Temporary barrier rail

Memo 9.1.6 et al.-2011 ~ Pedestrian and Bicyclist Access During Repair Projects

Unless a bridge can be closed during a repair project, vehicular access on the bridge must be maintained, but the bridge repair designer also needs to consider the needs of other users, including pedestrians and bicyclists on bridges with existing sidewalks, bicycle lanes, or shared use paths. For pedestrian and bicyclist access the designer cannot use the suggested temporary barrier rail layouts given in the Bridge and Culvert Repair section commentary [BDM C9.1.8.3] when developing a traffic control plan and should consult with the Office of Design and, in complex situations, also with the Office of Traffic and Safety. Along with pedestrian access the designer will need to address Americans with Disabilities Act (ADA) requirements. Although the Office of Design intends to consider all users and ADA when developing traffic control plans for work zones [OD DM 9A-1 and 9A-5] the bridge repair designer needs to be aware of the issues and consult with the Office of Design as soon as possible in special situations.

Example TBR layouts

1998

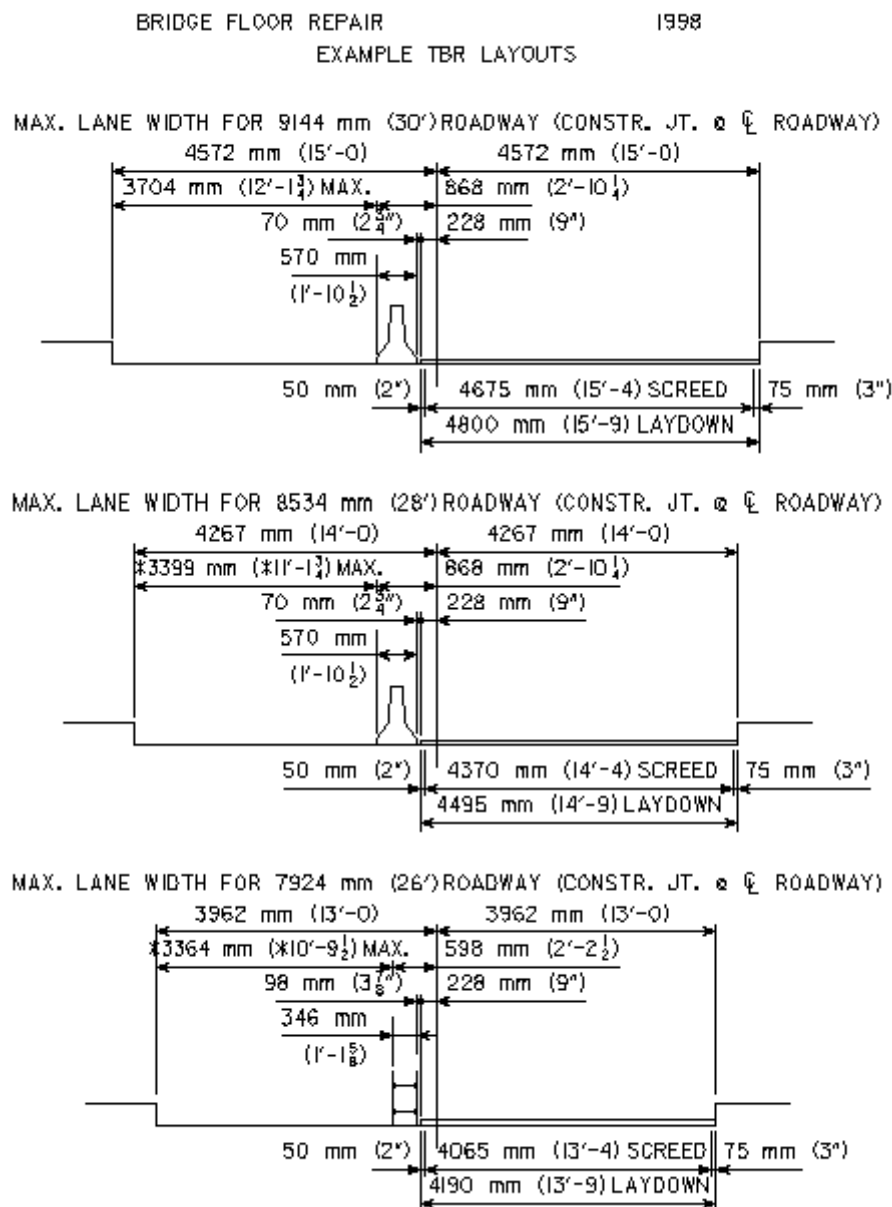


Figure note: All cases illustrated above require special signing because the roadway width is less than 14.50 feet (4.420 m) between barriers. If the lane width is less than 10.50 feet (3.780 m) the Office of Traffic and Safety also will need to review the TBR design. See the manual text [BDM 9.1.8.3].

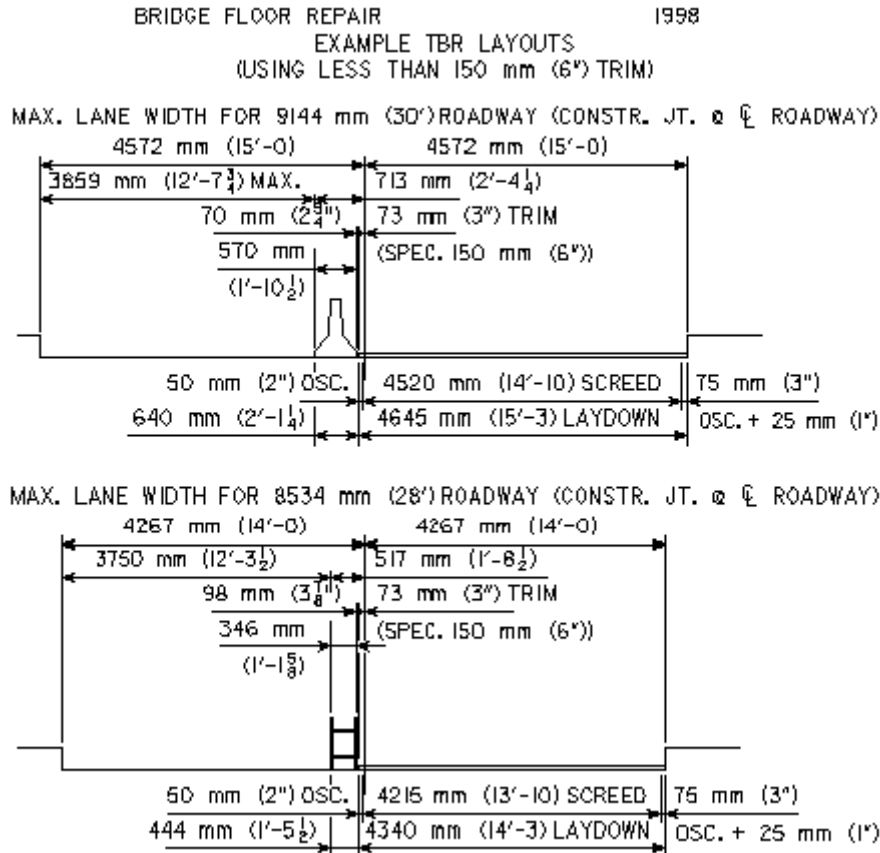


Figure notes: When less trim is used than required by the Standard Specifications, include deck repair note E432 or M432 [BDM 11.5.2]. Reduce trim only when needed to maximize roadway width.

All cases illustrated above require special signing because the roadway width is less than 14.50 feet (4.420 m) between barriers. If the width is less than 10.50 feet (3.780 m) the Office of Traffic and Safety also will need to review the TBR design. See the manual text [BDM 9.8.1.3].

Methods Memo No. 13: Analysis of Existing Slab Overhangs for TBR Loads (Note that the AASHTO reference is to the Standard Specifications.)
7 August 2001

C9.1.9 Programmed projects

C9.1.9.1 Repair

C9.1.9.1.1 Deck repairs

C9.1.9.1.2 Overlays

C9.1.9.1.3 Deck joints

C9.1.9.1.4 Drains and scuppers

C9.1.9.1.5 Curbs

C9.1.9.1.6 Miscellaneous concrete**C9.1.9.1.7 Backwalls and diaphragms**

Methods Memo No. 199: Revision to CADD Note E461/M461
1 May 2008

C9.1.9.1.8 Shotcrete**C9.1.9.1.9 Other****C9.1.9.2 Retrofit****C9.1.9.2.1 Doweled bars**

Iowa DOT Pullout Test Results
Prior to 25 August 1993

Plain and epoxy coated No.6 rebars were installed in 7/8" diameter holes in 4000 psi concrete at 4-inch and 6-inch depths, and pull-out loads were determined after a seven day epoxy cure. Results are as follows:

4-inch embedment depth

Bar type	Plain No. 6	Epoxy-coated No. 6
Test result	15,100 lb	12,750 lb
		11,000 lb
		10,100 lb
Average test result	15,100 lb	11,312 lb
With factor of safety of 4	3,775 lb	2,828 lb

6-inch embedment depth

Bar type	Plain No. 6	Epoxy-coated No. 6
Test result	20,000 lb	16,000 lb
		15,750 lb
		13,150 lb
Average test result	20,000 lb	14,975 lb
With factor of safety of 4	5,000 lb	3,744 lb

C9.1.9.2.2 TL-4 barrier rails

Methods Memo No. 190: LRFD Guidelines for Repair Projects
1 March 2008

Partially revised: Methods Memo No. 162: Bridge Railing Selection on Interstate and Primary Highways
29 June 2007

Partially revised: Methods Memo No. 206: Revision for E463/M463
1 October 2008

C9.1.9.2.2.1 Standard section

Methods Memo No. 207: Policy for Use of Steel Cover Plates for Concrete Barrier Rail Expansion Joint Openings and Limits on Conduit Size and Number in Concrete Barrier Rails (Article 5.8.1 Railings)
1 January 2009

C9.1.9.2.2.2 End sections

May 2013 ~ Sloped transitions for rigid barrier rail

The following information is from University of Nebraska via the Office of Design.

When transitioning the height of a rigid barrier, a taper rate of 10:1 is preferred. Where a more aggressive rate is needed, apply the following:

- Where the height of the lower barrier is less than 32 inches, use a maximum taper rate of 8:1.
- Where the height of the lower barrier is 32 inches or greater, use a maximum taper rate of 6:1.

C9.1.9.2.3 Cover plates

C9.1.9.2.4 Other

C9.1.9.3 Strengthening steel members

C9.1.9.3.1 Beams and girders

C9.1.9.3.2 Other

C9.1.9.4 Replacements

C9.1.9.4.1 Approach pavement

C9.1.9.4.2 Decks

Memo 9.1.9.4.2-2011 ~ Deck replacement

As the inventory of Iowa bridges ages, a deck overlay is not always sufficient for repair of a deteriorated deck, and the deck may need to be replaced. Generally deck replacements are the responsibility of final design, but the preliminary designer needs to be involved in projects that include significant bridge widening. There have been problems with deck replacement projects when bridges settled in service. Without surveys of the existing decks, the project plans showed deck elevations that would have resulted in very thick decks. Therefore the final designer needs to request a deck survey and base the deck elevations on the survey rather than on the original bridge plans.

A second issue with deck replacements is the resistance of existing angle-plus-bar shear lugs that were used in composite steel beam-deck design from about 1947 to about 1970. The ultimate strength (nominal resistance) of those lugs can be determined approximately from a modified AASHTO Standard Specifications channel connector formula. The formula is mentioned (but not given) in Part I of the final report for Iowa Highway Research Board project HR-238 and is as follows:

$$S_u = (550) (1.5 t) (W) (f'_c)^{0.5}$$

S_u = ultimate strength (nominal resistance), pounds

t = angle thickness, inches

W = angle width perpendicular to centerline of beam, inches

f'_c = 28-day strength of concrete in the new deck, psi

Shear resistance may be augmented with new shear studs if the existing angle-plus-bar lugs are insufficient based on design computations.

In addition, because the existing lugs and top flanges may be damaged during deck removal, there should be a field inspection to determine damage to the lugs and flanges. Any cracks in lugs above tension flanges need to be ground out so that cracks do not progress into the flanges. Also, gouges, nicks, and cuts in the tension flanges need to be repaired. After all damage has been addressed new shear studs need to be added to replace any shear resistance lost due to damage and repair of damage.

There is no specific information available for fatigue resistance of angle-plus-bar shear lugs.

During design the designer also needs to address potential lateral buckling of steel beams in superstructures with integral abutments. During service conditions the closely spaced shear connections to the deck prevent lateral buckling of beams in compression but, when the deck is removed, the lateral support is widely spaced at diaphragms only. In another state, the summer sun increased temperature in the steel beams, the beams expanded, pushed against the integral abutments, were unable to move the abutments back into the approach fills, and buckled laterally between diaphragms.

Reference: Klaiber, F.W., D.J. Dedic, K.F. Dunker, and W.W. Sanders, Jr. (1983). *Strengthening of Existing Single Span Steel Beam and Concrete Deck Bridges, Final Report Part I*. Engineering Research Institute, Iowa State University, Ames, Iowa. (Available on the Iowa DOT web site at:

http://www.iowadot.gov/operationsresearch/reports/reports_pdf/hr_and_tr/reports/HR-238.pdf)

C9.1.9.4.3 Other

C9.1.9.5 Coatings

C9.1.9.5.1 Scrape tests

C9.1.9.5.2 Cleaning and painting

Partially revised: Methods Memo No. 15: Repainting of Steel Bridges

30 September 2003 (Comments regarding note number changes and CADD note locations added 1 March 2005)

Partially revised: Methods Memo No. 141: Removal of Hazardous Paint

1 November 2005 (Comments regarding EPA number from Brad Azeltine, Office of Location and Environment, edited and added 27 December 2005)

Brad Azeltine's clarification on the timing of obtaining the EPA ID number: We need to wait until the painting contractor has generated some blast waste so it can be sampled and analyzed before we request a generator ID number from EPA (to confirm we have a hazardous waste). We also need the contractor to provide the quantity of waste expected to be generated, the estimated time period of the waste generation, and the expected number and timing of waste shipments. In other words, we typically won't have an ID number until the work is actually in progress. However, this is a moot point for those bridges that already have an EPA ID number (e.g. US20 J.D. Bridge, Allamakee IA9 over the Mississippi, Pottawattamie I-80 over the Missouri, etc.) In those cases, the ID number could be placed on the plans.)

C9.1.9.5.3 Concrete sealer

Methods Memo No. 12: Concrete Sealer on Repairs

16 July 2001

C9.1.9.5.4 Other

C9.1.10 Emergency projects

C9.1.10.1 PPCB overpass damage

C9.1.10.2 Steel beam or girder overpass damage

C9.1.10.3 Other

C9.1.11 Concept statements

**Partially revised: Methods Memo No. 165: Revision to C9.1.11 Concept Repair Memo
16 March 2007 (Note that Attachment A below has been pasted in from the original Methods Memo
No. 165 as three Microsoft Office Word Document Objects in order to preserve the formatting.)**

Form 000021wd
4-96

IOWA DEPARTMENT OF TRANSPORTATION

To Office	District X	Date	January 1, 2007
Attention	<District Maintenance Manager>	Ref No.	<County> County <Project Number>
From	<Bridge Design Engineer>		PIN <PIN>
Office	Bridges and Structures		Design No(s). <Design #> File No. <File #> FHWA No. <FHWA #>
Subject	<Revised> Concept for Bridge <Floor Overlay or Repair> of <Bridge size and type> Bridge Maintenance No. 0000.0X000		

The bridge on <Route> over <Route, River, RR, etc.> has been <scheduled or programmed> for <an overlay or a repair> to be let on <letting date>. < It is currently not in the five year program.> The <estimated or programmed> cost estimate is <estimated or programmed cost estimate>. I inspected the bridge on <Date> with <Bridge employees, other than yourself> of the Office of Bridges and Structures, and <Other personnel>, <Position> of <Office or consultant>.

EXISTING CONDITIONS

<Description of Bridge condition found from maint. report and inspection. Mention only conditions needing attention. Include rail type.>

<Description of Approach type and condition from maint. report, include guardrail type>

RECOMMENDATIONS

It is recommended that the following repairs be made:

1. <Be specific, a plan will be prepared based on this information>
- 2.

Traffic control will involve <TBR, Shoulder strengthening, traffic signals, floodlighting, etc.>

The District should provide a site survey of the utilities.

All recipients of this letter should review this concept of work to be accomplished and advise the Office of Bridges and Structures of any comments you have by <Date(approx. 3 weeks from date sent)>. After this time period, the concept will be considered approved or will be revised according to concerns.

Estimated cost of repairs is as follows:

	<u>QUANTITY</u>	<u>UNIT</u>	<u>RATE</u>	<u>AMOUNT</u>
Removal of Existing PC Overlay	1002	sy	\$10	\$10,020
Bridge Floor Overlay	1002	sy	\$50	\$50,100
Class A Bridge Floor Repair	26	sy	\$100	\$2,600
Removals (joint and rails)	1	LS	\$10,000	\$10,000
Retrofit Concrete Barrier Rail	670	ft	\$40	\$26,800
Concrete Repair (abut. footing, curb)	5	sf	\$1000	\$5,000
Steel Extrusion Joint with Neoprene	82	ft	\$100	\$8,200
Structural Concrete (joint repair)	10	cy	\$500	\$5,000
Flowable Mortar and Earth Fill	1	LS	\$2,000	\$2,000
Removal of Approach Pavement	136	sy	\$4	\$544
Reinforced Bridge Approach Section	136	sy	\$85	\$11,560
Guardrail	250	ft	\$16	\$4,000
RE-76 End Sections	4	ea	\$1,000	\$4,000
Temporary Flood Lighting	2	ea	\$1,580	\$3,160
Temporary Traffic Signals	2	ea	\$7,250	\$14,500
TBR	1250	ft	\$15	\$18,750
Traffic Control	1	LS	\$5,000	\$5,000
Mobilization & Contingencies (15%)	1	LS	\$24,000	<u>\$24,000</u>
			TOTAL	\$205,234

<Bridge Design Engineer's Initials(CAPITALS)>/baj

cc: <District Engineer>, <District>

<Asst. District Engineer>, <District>

<District Construction Engineer>, <District>

<District Operations Manager>, District Operations Manager, <City>

<Bridge Crew Leader>, Bridge Crew Leader, <District>

M. Kennerly, Design

<Design Section Leader>, Design

J. Ranney, Program Management

M. Swenson, Project Scheduling

J. Smith, Contracts

K. Mahoney, Highway Division

M. Dillavou, Engineering Bureau

D. Newell, Location and Environment

B. Brakke

N. McDonald

G. Novey

<Bridge Design Section Leader>

W. Sunday, Construction

File

Add to cc: if on Interstate:

C. Monk, FHWA

Add to cc: if RR is involved:

S. Banks, Rail Transportation

Add to cc: if consultant project:

<Consultant contact>, <Consultant>

R. Meyer

Note: Place a copy in the File envelope.

C9.1.12 Design documents

C9.1.12.1 Drawings

CADD Users Guidelines for CADD Delamtect Sheet

29 September 1997

Please have CADD users follow these guidelines when preparing the CADD delamtect sheet for deck repairs to provide consistency.

- (1) If there are additional spalls sent in from the field (hand drawn areas) these will need to be added to the delamtect sheet. These areas should be added in CADD, on level 2 with the appropriate line weight, color and drawn with the shape command with the fill turned off.
- (2) A text line stating the total area of these additional spalls should be added under the text line given for the delamtect area. No adjustment will be made for overlapping areas.

Note: The delamtect areas are on level 3 with a color of red. In the event that additional repair areas need to be added to the delamtect plot, the delamtect areas can be shut off when adding the additional repair areas.

The delamtect files will be named h____.dec initially. The file extension should be changed by the user to an ".S??" extension as appropriate.

C9.1.12.2 Specifications

C9.2 Culvert repair
